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DISTRIBUTIONAL DATA AND NEW SYNONYMY FOR SPECIES OF *HALOBATES* ESCHSCHOLTZ (HETEROPTERA: GERRIDAE) OCCURRING ON ALDABRA AND NEARBY ATOLLS, WESTERN INDIAN OCEAN

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Abstract.—Five species of *Halobates* are recorded from the atolls of the Aldabra group: *H. germanus, H. micans, H. alluaudi, H. poseidon,* and *H. flaviventris.* These species are keyed, the variability of the populations inhabiting Aldabra and Cosmoledo atolls discussed, and notes provided on their ecological preferences. *Halobates eschscholtzi* Herring 1961 is placed as a junior synonym of *Halobates flaviventris* Eschscholtz 1822 (new synonymy).

During an expedition to Aldabra atoll in March and April of 1989 the first author was able to make extensive collections of *Halobates* in the western Indian Ocean, which revealed unsuspected range extensions and previously undocumented levels of intraspecific variation in several species. This report is an outgrowth of those studies, and is intended as a faunistic contribution covering the *Halobates* species occurring on the small islands and atolls lying between the granitic Seychelles and Madagascar in the northwest quadrant of the Indian Ocean, particularly those of the Aldabra group. Since the last revision of *Halobates* by Herring (1961), the only significant papers dealing with the Indian Ocean have been those of Cheng (1974) and Polhemus and Cheng (1982). The first of these discussed the distributions of *H. flaviventris, H. micans,* and *H. germanus* around the island of Nosy Be and on offshore seas north of Madagascar, while the second provided new records for *H. poseidon* and *H. flaviventris* along the east coast of Africa. The atolls of the western Indian Ocean have been essentially overlooked in terms of their *Halobates* fauna, and since no regional treatment exists a key to their species is provided below. The key and discussions should be applicable to species occurring among the islands ringing the southern margin of the Somali Basin (see Fig. 1), including the following areas: the granitic Seychelles, the Amirantes (African Islands, Desroches, Poivre, Noeufs, Alphonse), Platt, Coetivy, Providence-Cerf, St. Pierre, Farquhar, Agalega and the Aldabra group (Aldabra, Assumption, Astove, Cosmoledo). The *Halobates* fauna of the Comores is essentially unknown, but should also contain many of these species. Additional endemic species not treated herein occur in Madagascar, the Mascarenes, along the eastern coast of Africa, and in the Red Sea.

The five species of *Halobates* recorded from Aldabra and Cosmoledo represent

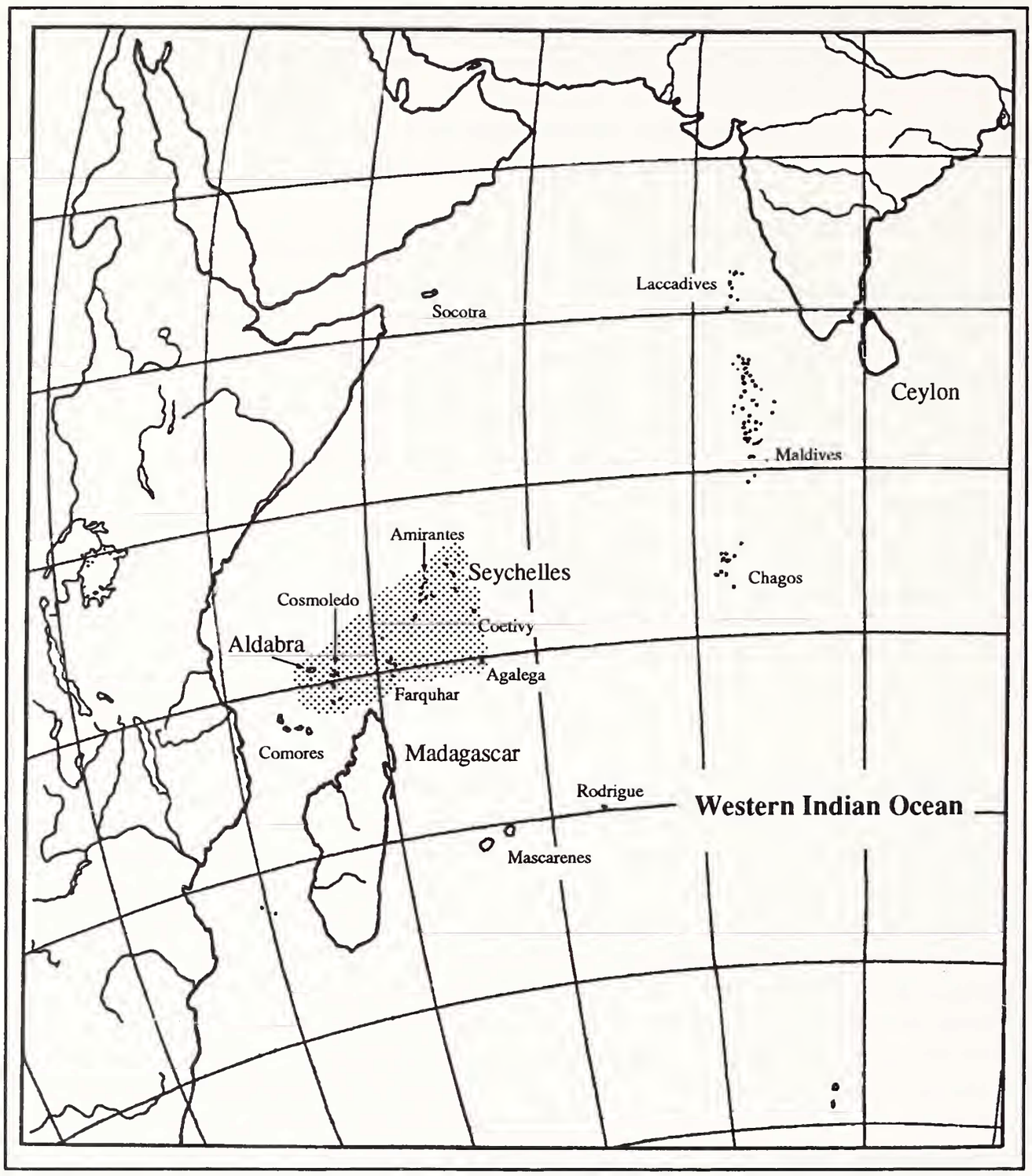

Fig. 1. Area of the western Indian Ocean covered by this work. The sizes of the small islands and atolls on the map have been exaggerated for the sake of resolution.

the greatest species diversity known from any coral atolls in the Indo-Pacific region. This species richness is likely due to the fact that these islands are raised, cliff-bound atolls which provide a wide range of reef, lagoon and mangrove habitats. The atolls harbor no endemic species, but the populations present on them often exhibit distinctive intraspecific variations in color pattern and setiferation which are indicative of incipient speciation (see further discussion below). Of the five species present, two (*micans* and *germanus*) are widespread pelagic species, one (*flaviventris*) is present in nearshore habitats throughout the Indo-Pacific, one (*alluaudi*) is shared with the

granitic Seychelles, and one (*poseidon*) is shared with east Africa. These atolls thus appear to have been colonized by *Halobates* species which have arrived from several different directions, and seem to lie in a contact zone between species assemblages typical of both the western and eastern portions of the Indian Ocean.

The local distribution and habits of species occurring on Aldabra atoll will be covered in far more detail by the first author in a forthcoming publication (D. Polhemus, in press), and the localities listed herein are only those which establish new distribution records. For a recent review of basic *Halobates* biology, ecology and distribution readers are referred to Cheng (1985). All material cited was collected by D. A. Polhemus and is deposited in the National Museum of Natural History, Washington, D.C. (USNM) along with many additional specimens not discussed below. Synoptic series are also held in the J. T. Polhemus collection, Englewood, Colorado (JTPC).

In the material examined sections, the names of individual islets making up the outer rings of Aldabra and Cosmoledo atolls are listed in bold face. CL numbers following localities refer to a numbering system used to reference ecological notes. The latitudes and longitudes given were determined by use of a Satnav global positioning system.

KEY TO THE SPECIES OF *HALOBATES* OCCURRING IN THE ALDABRA GROUP AND NEARBY ATOLLS, WESTERN INDIAN OCEAN

1a. Width of head between the eyes greater than its length; interocular width about 4 times the width of an eye; body usually unicolorous silvery grey, lacking extensive yellow or brownish markings on the thoracic and abdominal venter or on the dorsum of the head; open ocean species 2

1b. Width of head between eyes less than its length; interocular width distinctly less than 4 times the width of an eye; body marked with yellow or brownish on the abdominal and thoracic venter, and usually on the dorsum of the head (either as a posteriorly convex crescent-shaped mark or as a broad patch isolating an arrow shaped dark mark centrally); nearshore species 3

2a. Smaller species, length of male less than or equal to 4.00 mm, length of female less than or equal to 3.80 mm; male left styliform process not bent upwards, lying horizontally in lateral view; male tergite IX with patches of black bristles on lateral wings (see figs. 7–9 in Herring, 1961) ..... *germanus*

2b. Larger species, length of males greater than or equal to 4.40 mm, length of females greater than or equal to 4.00 mm; male left styliform process bent abruptly upwards, appearing vertical in lateral view; male tergite IX lacking patches of black bristles on lateral wings (see figs. 1–3 in Herring, 1961) ..... *micans*

3a. Foreleg with length of tarsal segment I longer than or equal to length of tarsal segment II (for male genitalia see figs. 73–75 in Herring, 1961) ..... *alluaudi*

3b. Foreleg with length of tarsal segment I distinctly shorter than length of tarsal segment II 4

4a. Foreleg with length of tarsal segment I less than or equal to ⅔ the length of tarsal segment II; male left styliform process not bent outward or visible from above (see figs. 52–54 in Herring, 1961) ..... *poseidon*

4b. Foreleg with length of tarsal segment I greater than ⅔ the length of tarsal segment II; male left styliform process bent outward, visible from above (see figs. 85–87 in Herring, 1961) ..... *flaviventris*

Halobates germanus White

Halobates germanus White 1883. Voyage Challenger, Rept. Zool. 7(19):50, pl. 1, fig. 6. [Type-locality given as "North Pacific Ocean."]

Discussion: This moderate sized pelagic species is widely distributed in the Indian and western Pacific oceans (see Andersen, 1982, pg. 370, fig. 629). The species was known previously from the coasts of Africa and Arabia, but had not been recorded from any atoll in the western Indian Ocean. At Aldabra *H. germanus* was always found on open seas at least 1,000 meters offshore, in company with *H. micans.*

Material examined: ALDABRA ATOLL, **Grande Terre**: 1 male, 1 female, open sea 1,000 m offshore of Dune Jean Luis, 9°27′94″S, 46°25′92″E, 11:30 hr, sea temp. 28°C., 8 March 1989 (USNM). **Malabar**: 2 males, 4 females, net tow on calm sea 1,000 meters offshore from Passe Gionnet to Passe Houareau, 12 March 1989, 09:00 hr, CL 8032 (USNM). COSMOLEDO ATOLL, **Menai**: 1 male, 1 female, calm sea 500 meters offshore of Johannes Point settlement site, 9°41′68″S, 47°32′26″E, 13:00 hr, 27 March 1989, CL 8041 (USNM).

Halobates micans Eschscholtz

Halobates micans Eschscholtz 1822. Entomographien 1:107, pl. 2, fig. 3. [Type-locality given as "Im sudlichen stillen Meere und im sudlichen atlantischen Meere"; types presumably in University of Dorpat.]

Discussion: This silvery, moderate sized pelagic species is widely distributed throughout all the tropical oceans of the world (see Andersen, 1982, pg. 370, fig. 629). As with *H. germanus,* this pelagic species was always found at least 1,000 meters offshore at Aldabra Atoll, and was never observed in the lagoon. Several collections of this species were also made on the open sea during the voyage to and from Aldabra. It was observed that the insects seemed to prefer the calm patches of water that often appeared on the otherwise slightly disturbed sea surface, and would rest in these in the same way that a freshwater species might use a sheltered eddy in a stream.

Material examined: ALDABRA ATOLL, **Grande Terre**: 2 males, 2 females, open sea 1,000 m offshore of Dune Jean Luis, 9°27′94″S, 46°25′92″E, 11:30 hr, sea temp. 28°C, 8 March 1989 (USNM). COSMOLEDO ATOLL, **Menai**: 2 females, on calm sea 1,000 meters offshore of northeast tip, 18:00 hr, 27 March 1989 (USNM). INDIAN OCEAN, **Somali Basin**: 5 males, 2 females, 5 immatures, 8°59′62″S, 48°33′28″E, 28 March 1989, on calm sea, 07:00 hr (USNM); 2 males, 3 females, 1 immature, 8°21′87″S, 49°32′23″E, 29 March 1989, on sea with light swell, 18:30 hr (USNM); 2 males, 1 female, 1 immature, 7°44′20″S, 50°26′39″E, 30 March 1989, on sea with moderate swell, 07:30 hr (USNM); 1 male, 7°6′78″S, 51°20′75″E, 30 March 1989, 18:00 hr (USNM).

Halobates alluaudi Bergroth

Halobates alluaudi Bergroth 1893. Rev. Ent. Caen 12:204. [Type-locality Seychelles Islands; types in Paris Museum according to Herring (1961).]

Discussion: This large silvery species is a strong and agile skater that appears to prefer the shelter of rocky shores. In the granitic Seychelles males of this species were

common in the nearshore shallows, while females skated on deeper water at much greater distances from shore and were difficult to capture without the aid of a boat. At Aldabra *H. alluaudi* occurred both in the lagoon and on the outer coasts of the atoll; individuals were observed skating against the incoming tidal current in the lagoon passes, in a manner analogous to freshwater gerrids holding station against the current on freshwater streams.

The material from both Aldabra atoll (males and females) and Cosmoledo atoll (males only) matches very well with topotypic specimens from the granitic Seychelles except that the females from Aldabra either entirely lack black setae on the mesonotum or have only a small scattering of short black setae on the anterior part, whereas in females from the granitic Seychelles the mesonotum is thickly covered with stiff black setae. The Aldabra females also possess fore femora that are light colored beneath, while in the populations on the granitic islands the fore femur is dark beneath. Both of these are key characters used by Herring (1961) in his monograph of the genus. The males from all three localities are the same in all important respects, thus we have concluded that all of our material belongs to *alluaudi.* The atoll populations have apparently genetically fixed slight differences that in our opinion do not constitute separate species characters.

Distant (1913) recorded this species from Mahe, Aldabra, Coetivy, the Amirantes, the Chagos Archipelago, and Port Sudan in the Red Sea. It is likely that Distant's species concept was broader than the modern interpretations of later authors, and his Red Sea and Chagos records should be considered questionable until the specimens upon which they were based can be examined. Coetivy and the Amirantes, would seem to fall logically into the known range of the species, but these low sandy islands do not provide the type of habitat favored by *H. alluaudi,* which occurs almost exclusively along rocky shores, and is rarely encountered over 1,000 meters offshore. *H. alluaudi* frequently occurs in sympatry with *H. flaviventris,* a widely distributed species that tends to be found in open offshore waters, and the two species are superficially rather similar, being elongate and silvery. It thus seems possible that Distant's records of *H. alluaudi* from Coetivy and the Amirantes may be based on misidentified specimens of *H. flaviventris.*

Material examined: ALDABRA ATOLL, **Picard**: many males and females, rocky islets and mangrove clumps of *Sonneratia alba* at La Gigi, near Passe Femme, CL 8027, 11 March 1989 (USNM, JTPC). COSMOLEDO ATOLL, **Menai**: 5 males, calm sea 500 meters offshore of Johannes Point settlement site, 9°41′68″S, 47°32′26″E, 13:00 hr, CL 8041, 27 March 1989 (USNM). SEYCHELLES, **Mahe**: 17 males, 1 female, along rocky granite coast at Port Glaud, L'Islette Bay, CL 8043, 1 April 1989 (USNM, JTPC).

Halobates poseidon Herring

Halobates poseidon Herring 1961. Pac. Ins. 3:287. [Type-locality Mombasa, Kenya; holotype in British Museum (Natural History).]

Discussion: At Aldabra this small dark grey species was typically encountered along the margins of the lagoon, and frequently schooled in mangrove lined channels. Populations were also present in several limestone sinkholes in the interior of Picard

Island, which were flooded with seawater via subterranean passages but lacked any direct connections to the sea.

The material from Aldabra matches very well with specimens at hand from Kenya, Tanzania and Madagascar, however the Cosmoledo specimens exhibit a remarkable color shift, particularly in the females, wherein the central portions of the mesonotum and head are broadly infused with orange. Some Cosmoledo males have a more or less normal coloration, but all females have the distinctive orange pattern. We originally thought these populations must represent a new species, but all structural characteristics are the same as other populations of *poseidon,* thus we conclude that this is yet another example of genetic drift in an isolated population.

Material examined: ALDABRA ATOLL, **Grande Terre**: many males and females, mangrove estuary lined with *Avicennia marina* at upper end of L'Eglise Channel, off Takamaka Arm, 14 March 1989, CL 8031 (USNM, JTPC). **Picard**: 8 males, 5 females, Upsidedown Jellyfish Pool, nr. Aldabra Research Station, 9 March 1989, CL 8022 (USNM). COSMOLEDO ATOLL, **Menai**: many males and females, along sheltered sandy shore lined with *Avicennia marina,* on lagoon side across from Johannes Point settlement site, 9°41′68″S, 47°32′26″E, 27 March 1989, 10:00 hr, CL 8041 (USNM, JTPC).

Halobates flaviventris Eschscholtz

Halobates flaviventris Eschscholtz 1822. Entomographien 1:109, pl. 2, fig. 5. [Type-locality given as "Im sudlichen atlantischen Meere," doubted by Herring (1961); types presumably in University of Dorpat.]

Halobates eschscholtzi Herring 1961. Pac. Ins. 3:254 [Type-locality Zanzibar; holotype in British Museum (Natural History).] (New synonymy).

Discussion: This moderately large and elongate silvery species was usually found 100 to 500 meters offshore on the sheltered north and west coasts of Aldabra. In its habits it was intermediate between the open ocean forms and the nearshore species, with a behavior pattern similar to that observed for *H. princeps* White in the Malay Archipelago. Individuals would cruise outside of and parallel to the reef crest fringing the outer coasts, and were never observed in the lagoon.

Herring described *H. eschscholtzi* from females taken at Zanzibar, placing it in his open ocean group on the basis of a wide interocular space "approximately 4× width of an eye," and comparing it with *H. micans* Eschscholtz and *H. splendens* Witlaczil. We have studied one paratype, somewhat teneral, that agrees with his description, and find that his placement of this species in the open ocean group is not correct. The apparently wide interocular space/width of eye ratio is due to a slight shrivelling of the eyes, and the ventral abdominal segments have yellowish areas, so that actually the species should be placed with those species that occur near shore. With females and males now available from Aldabra and Cosmoledo atolls, as well as Tanzania, it becomes evident that *eschscholtzi* is a synonym of *flaviventris.* We have specimens of *flaviventris* from the New Hebrides and Palau that are slightly smaller than those from the western Indian Ocean and have a narrower interocular space, as well as intermediate forms from Ceylon, thus it appears that there is a clinal pattern for this character across the Indo-Pacific region associated with variations in body size.

Material examined: ALDABRA ATOLL, **Picard**: 2 males, net tow 100 meters

offshore of rocky coast from Research Station to Grande Passe, 16 March 1989 (USNM). **Polymnie**: 2 males, in net tow 30 m offshore of north coast from Grande Passe to Passe Gionnet, CL 8034, 16 March 1989 (USNM). **Malabar**: 2 males, net tow on calm sea 1,000 meters offshore from Passe Gionnet to Passe Houareau, 12 March 1989, 09:00 hr, CL 8032 (USNM). COSMOLEDO ATOLL, **Menai**: 1 male, 3 females, calm sea 500 meters offshore of Johannes Point settlement site, 9°41′68″S, 47°32′26″E, 13:00 hr, 27 March 1989, CL 8041 (USNM).

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